European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.3463660 Volume 6 | Issue 6 | 2019

# ACHIEVEMENT TEST DEVELOPMENT STUDY FOR STEP CONCEPT

**Yasemin Kubanç**[i]
Fırat University,
Faculty of Education,
Turkey

**Abstract:**
This study was carried out with the aim of developing a valid and reliable achievement testing natural numbers by taking into account the steps of achievement test development. In the development of the achievement test, the 17 acquisitions related to the concept of step value in natural numbers in the field of learning of numbers and operations in the 4th Grade Mathematics Course Curriculum (2018) were taken into consideration. Based on the literature review, a draft achievement test consisting of 4 items, 68 items in total, was developed. In order to ensure the consistency of the prepared test items and their consistency with scientific information, various arrangements have been made in the test items by making use of the opinions of 4 faculty members specialized in the field of classroom education, mathematics education and measurement. A pilot application was carried out with 136 elementary school 4th Grade students. In accordance with the answers of the students to the questions in the test, item analysis was performed, and the discrimination indexes of each item were calculated separately. As a result of the item analysis, 40 items that were not easy to distinguish as easy and difficult and that did not have good item discrimination features were removed from the test, and the achievement test consisting of 28 items was obtained for the concept of step. The mean difficulty of the achievement test was .56, and the mean discrimination feature was .45. The data obtained from the item analysis of the test were analyzed using ITEMAN and Microsoft Office Excel 2007 programs; and the KR-20 reliability coefficient of the test was calculated as .885.

**Keywords:** step concept, achievement test, primary school, mathematics

## 1. Introduction

*"The value represented by a digit in a number on the basis of its position in the number is defined as the place value" (Arslan & Ubuz, 2009: 98).* The concept of digit is an issue that

[i] Correspondence: email y_kubanc@hotmail.com

has an important place in mathematics and is the basis of the number system and arithmetic we use. Although it seems simple, it is one of the topics that students have the most difficulty in understanding. As a matter of fact, Thompson and Bramald (2002) state that 2nd and 3rd grade students in primary school do not understand the concept of digit at all based on the results of their studies. Measurement and evaluation activities are important in determining the present difficulties of students, their readiness levels in terms of cognitive, affective and psychomotor skills, and to assess the level of realization of teaching objectives (Gonen, Kocakaya & Kocakaya, 2011).

Educational institutions engage in a systematically planned knowledge and skill-building activity for students (Kaya, 2015). Various assessment and evaluation tools are used to determine the level of knowledge and skills acquired by students. In the constructivist approach, assessment and evaluation is a part of the teaching process and it is used both in determining the readiness levels of students before learning, in determining the attitudes of students towards the course in the learning process and in determining the level of achievement of the students at the end of learning. For these purposes, educators use various measurement tools such as open-ended questions, multiple choice questions, true-false questions and matching activities in order to measure students' performance (Karip, 2012). However, the majority of the measurement tools used in schools are non-standard tests prepared by teachers. Therefore; objective, valid and reliable achievement tests are needed to determine the quality and quantity of learning and achievement level in students (Fidan, 2013).

*"At the end of a learning process, tests that measure the knowledge gained, thus, the achievement are called achievement tests"* (Baser, 1996: 19). A good achievement test should be valid, reliable, objective, distinctive and useful. An achievement test can consist of both multiple-choice and open-ended questions. In the achievement tests consisting of open-ended questions, the students are free to determine the degree of importance they will attach to the form of approach to the subject, to the solution method of the question and to each of the points covered in their answer (Temizkan & Sallabas, 2011). In addition, it is stated that open-ended items are more advantageous than multiple-choice tests in measuring high-level skills (Bahar et al., 2012). Therefore, the achievement test developed in this study consists of open-ended questions.

Achievement test for multiplication of natural numbers (Ucuncu, 2010), achievement test for counting learning field in 1st, 2nd, 3rd, 4th grades (Fidan, 2013), readiness test for 6th grade numbers learning field (Ucgul Ocal, 2011), mathematics achievement test for 9th grade students (Baser, 1996), development of an achievement test on clusters, correlation, function (Narli & Baser, 2008), an achievement test aimed at measuring geometry achievements of 5th grade students (Sahin & Kesan, 2017) can be given as examples for the subjects of achievement tests in mathematics education. When the achievement tests in the field of mathematics were examined, an achievement test developed for the concept of digit could not be found. It is expected that this aspect of the study will contribute to the field and shed light on future studies.

## 2. Method

In this study, it is aimed to develop an achievement test with proven validity and reliability for 4th grade students in the field of learning numbers and operations for the concept of digit in natural numbers. For this purpose, firstly, the steps of developing achievement test were investigated based on the literature review. Accordingly, the following steps suggested by Turgut and Baykul (2012) were taken into consideration in the development of the achievement test:

- Determining the purpose for which the test will be used;
- Determining the behaviors (achievements) to be measured in the test;
- Writing appropriate test items for the achievements;
- Review of items through expert opinion;
- Preparation of the draft form;
- Application of the draft form;
- Item analysis, validity and reliability study and selection of items at the end of the application;
- Establishing the final achievement test.

The sample of the study consists of 136 4th grade students attending two public schools in Elazig city center in 2017-2018 spring semester. While the schools were selected according to the convenience sampling method, the criterion sampling method was used in the selection of the students. As a criterion, all 4th grade students at these schools were invited to the study and 136 students agreed to participate voluntarily and with the consent of their parents.

Turgut and Baykul (2012) state that the duration of the exam is long enough for all the students to be motivated to answer questions carefully and quickly and long enough to answer all the questions, underlining that this is necessary to ensure reliability in measuring. Since the application of the test will be difficult and tiring for the fourth grade students to solve 68 questions at once, in line with the opinions received from the classroom teachers, the draft achievement test was divided into three sections as 24, 24 and 20 questions and applied in three sessions with 10 minute intervals. Each session lasted 40 minutes. Draft tests were given to each student and the students were asked to answer the questions in the classroom within the time period determined.

In accordance with the steps of the test development process, an item analysis was conducted in order to determine the item properties and validity and reliability of the 68-question draft achievement test. The correct answers given by the students to the questions were coded as 1, the wrong and empty answers were coded as 0. The number of correct answers was taken into consideration as the achievement criteria. ITEMAN and Microsoft Office Excel 2007 software applications were used for data analysis. The reliability study of the draft achievement test was performed by calculating the Kuder-Richardson (KR-20) reliability coefficient. The reliability coefficient calculated with the KR-20 formula gives the consistency of the test items with the whole test (Turgut & Baykul, 2012). According to Turgut and Baykul (2012), the Kuder-Richardson-20 (KR-

20) test, which reveals the consistency of the items in the measuring instrument with each other, should be used as a method of determining the reliability of a measuring instrument with a single application. In many studies in which achievement tests were developed, it is seen that reliability was analyzed by calculating the KR-20 reliability coefficient. Additionally, the KR-21 formula is used in situations where the degree of difficulty of all items in the test is equal (Baser, 1996).

## 3. Findings

Based on the steps to be followed while developing an achievement test (Turgut and Baykul, 2012), the researcher developed an "Achievement Test for the concept of place value". The steps followed in the development of the achievement test are presented below under separate headings.

**Stage I:** The purpose of the achievement test is to provide an achievement test with proven validity and reliability for the 4th grade students on digits in natural numbers which is in the learning area of "Numbers and Operations".

**Stage II:** After the purpose of the test was determined, it was decided to determine the achievements to be measured in the test, the number of items to be included in the test, the duration of the test and the type of items to be included in the test. First of all, the acquisitions related to the concept of place value in natural numbers in the learning area of "Numbers and Operations" included in Primary School 4th Grade Mathematics Curriculum (2018) were determined. In addition, the researcher wrote acquisitions for the concept of place value taking into consideration the prerequisite acquisitions included in the learning area of "Numbers and Operations" in Primary School 1st, 2nd and 3rd Grade Mathematics Course Curriculum (2018), which are expected to be gained at the end of primary school. It is aimed to reveal the general status of primary school students related to the concept of place value at primary school level by including questions that measure these acquisitions in the achievement test. There are five sub-learning areas in the field of Numbers and Operations: "Natural numbers, addition in natural numbers, subtraction in natural numbers, multiplication in natural numbers and division in natural numbers". In the achievement tests prepared to determine the level reached at the end of the learning process, having questions for each of the acquisitions in the curriculum may cause much more questions to appear in the test than students can answer, which may lead to a decrease in the usefulness of the test (Fidan, 2013). For this reason, behaviors that reflect progress and developments better in line with the objectives of the subject area should be specifically selected and measured (Ozcelik, 2010). Therefore, there are a total of 28 acquisitions in the sub-learning areas considered, while 17 acquisitions directly related to the concept of place value were chosen by the researcher.

Table 1 shows the sub-learning areas and acquisitions in the Numbers and Operations Learning Area of 2018 Primary School 4th Grade Mathematics Course Curriculum which are included in the achievement test. In addition, the acquisitions

added by the researcher about the pre-learning required for the 4th grade are given in Table 1.

**Table 1:** Acquisitions in the 4th Grade Numbers and Operations Learning Area of the 2018 Primary School Mathematics Course Curriculum which are included in the achievement test

| Learning Area | Sub-Learning Area | Acquisitions |
|---|---|---|
| Numbers and Operations | Natural Numbers | K1. Reads and writes 4-, 5- and 6-digit natural numbers.<br>K2. Identifies and analyzes the orders and digits of the 4-, 5- and 6-digit natural numbers and the place values of the digits in the numbers.<br>K3. Rounds up natural numbers to the nearest decimal or hundred. A maximum of four digits are used.<br>K4 Sorts up to six digits of natural numbers using greater than/less than symbols.<br>*K5. Shows four-digit numbers using a model<br>*K6. States how many units form how many tens, how many tens form how many hundreds.<br>*K7. Recognize the relationships between numbers and patterns in the hundreds table |
| | Addition in Natural Numbers | K8 Makes addition with up to four-digit natural numbers.<br>K9 Solves problems that require addition with natural numbers |
| | Subtraction in Natural Numbers | K10. Makes subtraction with up to four-digit natural numbers.<br>K11. Solves problems that require subtraction with natural numbers. |
| | Multiplication in Natural Numbers | K12 Multiplies three-digit natural numbers by two-digit natural numbers.<br>K13. Solves problems that require multiplication with natural numbers. |
| | Division in Natural Numbers | K14. Divides three-digit natural numbers by up to two-digit natural numbers<br>K15. Divides a maximum of four-digit number by a one-digit number.<br>K16. Divides up to five-digit natural numbers the last three digits being zero by 10, 100 and 1000.<br>K17. Solves problems that require division with natural numbers. |

* Acquisitions added by the researcher

As can be seen in Table 1, there are 4 acquisitions related to the concept of place value in the natural numbers sub-learning are in the Primary School 4th grade Mathematics Teaching Curriculum. In addition to these acquisitions, the researcher added the acquisitions of "Shows four-digit numbers using the model; Expresses how many units form how many tens, how many tens form how many hundreds; and Recognizes the patterns and relationships between the numbers in the hundreds table" to the sub-learning area of natural numbers. The reason for the addition of these acquisitions by the researcher is that there are acquisitions in the primary school 1st, 2nd and 3rd grade mathematics course curriculum for the topic of showing digits with a model and

expressing them in different ways. Likewise, 2 acquisitions in the sub-learning area of addition in natural numbers, 2 acquisitions in the sub-learning area of subtraction in natural numbers, 2 acquisitions in the sub-learning area of multiplication in natural numbers and 4 acquisitions in the sub-learning area of division in natural numbers were included in the draft achievement test. Expert opinion was taken to clarify that the acquisitions identified by the researcher as critical acquisitions are indeed critical acquisitions in the area. The experts whose opinions and suggestions were received, including 2 academicians in the field of Class Education and 1 academician in the field of Curriculum Development in Education.

**Stage III:** Another stage was to write questions for each of the acquisitions that are clarified by taking expert opinions. Before writing questions for the achievement test, the dimensions and components of the questions prepared for students were investigated in the literature. In this context, the question styles of the data collection tools in the textbooks, test booklets and on the internet were examined in order to reveal the level of learning of the students for the concept of place value in line with the research problems. In order to determine which question types and contents would be better for measuring the determined acquisition, these questions were tried to be formed in different forms and contents as much as possible. For example; A question of dividing in the form of 'one under the other' was written for the acquisition of "Divides a three-digit number by a two-digit number, and a side-by-side question of dividing for the acquisition of "Makes division by 10 and its multiples using the short method". It is thought that it is important to put more questions into the test for the first trial than the number of items to be included in the test (Baser, 1996). For this reason, considering the content validity of the literature and achievement test, 4 open-ended questions measuring each acquisition were prepared in line with expert opinions and a draft achievement test was developed.

The content validity of the study should be examined in order to understand whether the prepared draft achievement test reflects the desired behaviors adequately (Buyukozturk, Cokluk & Koklu, 2011). One way to ensure content validity is the tables of specifications. The tables of specifications are the display of target behaviors and curriculum content on a two-dimensional table. In this study, the table of specifications in Table 2 was prepared to ensure the content validity. Table 2 shows the table of specifications demonstrating the learning area, sub-learning areas, acquisition, number of questions, and percentage of questions taken into consideration when developing the draft achievement test.

**Table 2:** The Table of Specifications for the Values Considered while Developing Achievement Test for the concept of place value

| Learning Area | Sub-Learning Area | Number of Acquisitions | Acquisition No. | Cognitive Level | Number of Questions | Percentage of Questions |
|---|---|---|---|---|---|---|
| Numbers and Operations | Natural numbers | 7 | K1 | Comprehension | "4 | 41 |
| | | | K2 | Comprehension | "4 | |
| | | | K3 | Comprehension | "4 | |
| | | | K4 | Comprehension | "4 | |
| | | | K5 | Practice | "4 | |
| | | | K6 | Analysis | "4 | |
| | | | K7 | Analysis | "4 | |
| | | | | | 28 | |
| | Addition in Natural Numbers | 2 | K8 | Practice | "4 | 11,7 |
| | | | K9 | Practice | "4 | |
| | Subtraction in Natural Numbers | 2 | K10 | Practice | "4 | 11,7 |
| | | | K11 | Practice | "4 | |
| | Multiplication in Natural Numbers | 2 | K12 | Practice | "4 | 11,7 |
| | | | K13 | Practice | "4 | |
| | Division in Natural Numbers | 4 | K14 | Practice | "4 | 23,5 |
| | | | K15 | Practice | "4 | |
| | | | K16 | Practice | "4 | |
| | | | K17 | Practice | "4 | |
| | **Total** | **17** | | | **68** | **100** |

As can be seen in Table 2, there are 7 acquisitions and 28 questions in natural numbers sub-learning area, 2 acquisitions and 8 questions in the sub-dimension of addition of natural numbers, 2 acquisitions and 8 questions in the sub-dimension of subtraction of natural numbers, 2 acquisitions and 8 questions in the sub-dimension of multiplication of natural numbers, and 4 acquisitions and 16 questions in the sub-dimension of division of natural numbers included in the achievement test for the concept of place value. In total, there are 68 questions in five sub-learning areas. In the test, there are 4 acquisitions and 16 questions in the comprehension stage, 11 acquisitions and 44 questions in the application stage and 2 acquisitions and 8 questions in the analysis stage. It can be said that the acquisitions and questions are mostly related to the application stage of the cognitive level.

Since there are 7 acquisitions in the sub-learning area of natural numbers in the specifications table, 41% of the questions are directed to the concept of place value in natural numbers. Since the number of acquisitions in the sub-learning areas of the addition, subtraction and multiplication operations in natural numbers is equal, the question weights for these sub-learning areas are the same (11.7%). Finally, there are 4 acquisitions and 16 questions in the sub-learning area of division of natural numbers and these questions constitute 23.5% of the achievement test.

**Stage IV:** Another logical way of examining the content validityis to seek expert opinion. For the draft achievement test of 68 questions prepared to check the appropriateness of the questions written for the critical acquisitions determined; the opinions of nine experts including, 2 from Gazi University Gazi Faculty of Education, 1 from Hacettepe University Faculty of Education, 3 from Firat University Faculty of Education, and 3 classroom teachers, were obtained independently from each other. 3 of the experts are associate professors, 3 are faculty member doctors and 3 are primary school teachers in schools affiliated to the Ministry of National Education. These experts were asked to evaluate; a) whether each question in the draft achievement test is appropriate for the relevant achievement, b) whether they are easily understood by the target audience. A form was created to provide the evaluation, opinions and suggestions for each question.

**Sample Question**

Learning Area: Numbers and Operations
Sub-Learning Area: Natural Numbers
Acquisition: Reads and writes 4, 5 and 6 digit-numbers.

| Q1. Fill in the dotted line with the written form of the number Ayşe wrote on the board. | | |
|---|---|---|
|   | | |
| Acceptable | Partly Acceptable | Not Acceptable |

The achievement test was revised in accordance with the opinions of experts regarding the suitability of the data collection tool in terms of content and narrative intelligibility, and the items that were not related to the research subject and that were similar were corrected. In addition to this, some words or sentences were corrected in line with expert opinions with the idea that students might have difficulty in understanding during the achievement test, the visuals in the achievement test were enriched and bigger type sizes were used.

**Stage V:** Turgut and Baykul (2012) suggest that the items should be grouped according to the subjects in the achievement tests in order to prevent mental fatigue while answering the test items. In addition, it is stated that the ordering of the items from easy to difficult will enable the students to answer the questions willingly. Considering that the acquisitions in the curriculum are progressing gradually, and that the order of acquisitions in the curriculum is also the order of difficulty; the items for the same acquisition are given one after the other. In line with these suggestions, the draft achievement test consisting of 68 questions in its final form was made ready for implementation.

**Stage VI:** In accordance with the steps of the test development process, an item analysis was conducted in order to determine the item properties and validity and reliability of the 68-question draft achievement test. The correct answers given by the 136 students to the 68 questions in the draft test were coded as 1, the incorrect and empty answers were coded as 0. The statistical results of item difficulty index (p), item distinctiveness index (rjx), item standard deviation (Sj) and reliability coefficient (KR-20) of the scores obtained from the application results are given in Table 3.

The reliability coefficient is generally higher than .70, which means that the test scores are reliable in terms of internal consistency (Buyukzoturk, 2007). A reliability score above .90 increases the quality of the test (Baser, 1996). The KR-20 internal consistency coefficient calculated for the reliability analysis of the draft achievement test was found to be .96. This finding shows that the items constituting the draft achievement test are the consistent with each other and with the whole test, thus, the test is very reliable in terms of internal consistency. According to Turgut and Baykul (2012), a high reliability coefficient of KR-20 is an indicator of the high reliability of the test as well as the fact that the feature measured is unidimensional. The mean difficulty value of the test was .71. This finding shows that test is made up of easy items.

Priority should be given to the coefficient of discriminative power in the selection of items (Turgut and Baykul, 2012; Baser, 1996). The rationale for this priority is that the item discriminative power is directly related to the validity, the degree which the test serves to the measurement purpose. Therefore, since the purpose of the draft achievement test developed in this study is to measure student achievement, the discriminative indices of the items were first taken into consideration in order to differentiate the participants who had acquired and those who had not acquired the desired outcomes through the test items.

Turgut and Baykul (2012) stated that it would be appropriate to accept items with an item discrimination index value of .30 and above for the final achievement test. When the findings in Table 3 are examined, the discriminative index of items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 17, 21, 22, 23, 25, 26, 41, 45 and 48 is below .30 and should be removed from the draft achievement test. Of these; items numbered 2, 6, 8, 9, 15, 17, 22, 23 and 41, are in the range of 0.20 and 0.29 and items that can be corrected and reused; while items numbered 1, 3, 4, 5, 7, 10, 21, 25, 26, 45 and 48 are items that must be removed from the test, having an index value below 0.19. Since there should be at least one question that measures each acquisition in order to ensure content validity, questions 4 and 6 were not excluded from the achievement test as an exception. In this context, items 4, 6, 11, 12, 13, 14, 16, 18, 19, 20, 24, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 42, 43, 44, 46, 47, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67 and 68 are included in the final achievement test.

Since some of the items included in the final achievement test measure the same acquisition, item difficulty levels of the questions were examined. Items 4, 6, 11, 14, 18, 19, 24, 29, 30, 31, 32, 37, 38, 39, 40, 47, 49, 51, 52, 53, 57, 61, 62, 63, 64 and 65 with difficulty level 0.65 and above -very easy-easy- and 0.34 and below -very difficult-difficult- are planned to be removed from the final achievement test. However, in order

not to reduce the content validity, items 4, 6, 24, 29, 40 and 63 are excluded from this rule. In this context, the final achievement test consists of a total of 28 items including items numbered 4, 6, 12, 13, 16, 20, 24, 27, 28, 29, 33, 34, 35, 36, 40, 42, 43, 44, 46, 50, 54, 58, 59 60, 63, 66, 67 and 68.

**Stage VII:** After the necessary arrangements were made after the implementation, the "Achievement test for the concept of place value" with a total of 28 questions was obtained. Table 4 shows the results of item analysis for the final achievement test obtained.

**Table 3:** Item Analysis Values for the Draft Achievement Test for the concept of place value

| Item No | Item Difficulty Index (pj) | Item Discrimination Index (rjx) | Item No | Item Difficulty Index (pj) | Item Discrimination Index (rjx) | Item No | Item Difficulty Index (pj) | Item Discrimination Index (rjx) | Item No | Item Difficulty Index (pj) | Item Discrimination Index (rjx) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Question 1 | 1,00 | 0 | Question 18 | 0,69 | 0,57 | Question 35 | 0,60 | 0,54 | Question 52 | 0,68 | 0,68 |
| Question 2 | 0,99 | 0,20 | Question 19 | 0,71 | 0,50 | Question 36 | 0,61 | 0,44 | Question 53 | 0,83 | 0,69 |
| Question 3 | 0,92 | 0,19 | Question 20 | 0,53 | 0,65 | Question 37 | 0,89 | 0,44 | Question 54 | 0,56 | 0,41 |
| Question 4 | 0,89 | 0,19 | Question 21 | 0,82 | 0,10 | Question 38 | 0,87 | 0,51 | Question 55 | 0,80 | 0,63 |
| Question 5 | 0,91 | 0,09 | Question 22 | 0,84 | 0,29 | Question 39 | 0,81 | 0,52 | Question 56 | 0,86 | 0,64 |
| Question 6 | 0,87 | 0,25 | Question 23 | 0,75 | 0,21 | Question 40 | 0,65 | 0,46 | Question 57 | 0,79 | 0,70 |
| Question 7 | 0,96 | 0,09 | Question 24 | 0,77 | 0,30 | Question 41 | 0,80 | 0,26 | Question 58 | 0,60 | 0,49 |
| Question 8 | 0,92 | 0,20 | Question 25 | 0,91 | 0,11 | Question 42 | 0,54 | 0,41 | Question 59 | 0,60 | 0,54 |
| Question 9 | 0,83 | 0,23 | Question 26 | 0,88 | 0,11 | Question 43 | 0,45 | 0,43 | Question 60 | 0,62 | 0,46 |
| Question 10 | 0,72 | 0,08 | Question 27 | 0,44 | 0,37 | Question 44 | 0,37 | 0,39 | Question 61 | 0,69 | 0,67 |
| Question 11 | 0,66 | 0,33 | Question 28 | 0,57 | 0,47 | Question 45 | 0,79 | 0,14 | Question 62 | 0,73 | 0,69 |
| Question 12 | 0,51 | 0,30 | Question 29 | 0,86 | 0,52 | Question 46 | 0,63 | 0,47 | Question 63 | 0,65 | 0,59 |
| Question 13 | 0,38 | 0,54 | Question 30 | 0,88 | 0,45 | Question 47 | 0,74 | 0,42 | Question 64 | 0,71 | 0,71 |
| Question 14 | 0,67 | 0,56 | Question 31 | 0,87 | 0,45 | Question 48 | 0,63 | 0,13 | Question 65 | 0,76 | 0,58 |
| Question 15 | 0,76 | 0,25 | Question 32 | 0,93 | 0,43 | Question 49 | 0,68 | 0,61 | Question 66 | 0,43 | 0,51 |
| Question 16 | 0,55 | 0,35 | Question 33 | 0,57 | 0,36 | Question 50 | 0,63 | 0,67 | Question 67 | 0,47 | 0,62 |
| Question 17 | 0,90 | 0,26 | Question 34 | 0,51 | 0,33 | Question 51 | 0,74 | 0,56 | Question 68 | 0,62 | 0,72 |
| Number of People Tested= 136 | | | | | | Standard Deviation of Test = 12.28 | | | | | |
| Test Average = 26.22 | | | | | | Average Difficulty of the Test = .71 | | | | | |
| KR-20 Value of the Test = .96 | | | | | | | | | | | |

In Table 4, where the final version of the achievement test is presented, there are 9 questions in the sub-learning area of natural numbers while there are 5 questions in the sub-learning area of addition in natural numbers. Again, there are 4 questions in the sub-learning area of subtraction in natural numbers while there are 2 questions in the sub-learning area of multiplication in natural numbers. Finally, there are 8 questions in the sub-learning area of division in natural numbers. The reliability of the 28-item final achievement test obtained after the application was found to be quite high at .885 level. Table 5 presents the distribution of the items in the final achievement test according to difficulty categories and levels of discrimination.

**Table 4:** The results of item analysis for the final version of the achievement test for the concept of place value

| Sub-Learning Area | Acquisition No. | Item No | Item Difficulty Index (pj) | Item Discrimination Index (rjx) | Sub-Learning Area | Acquisition No. | Item No | Item Difficulty Index (pj) | Item Discrimination Index (rjx) |
|---|---|---|---|---|---|---|---|---|---|
| Natural numbers | K1 | Question 4 | 0,89 | 0,19 | Subtraction in Natural Numbers | K10 | Question 40 | 0,65 | 0,46 |
| | K2 | Question 6 | 0,87 | 0,25 | | K11 | Question 42 | 0,54 | 0,41 |
| | K3 | Question 12 | 0,51 | 0,30 | | | Question 43 | 0,45 | 0,43 |
| | K4 | Question 13 | 0,38 | 0,54 | | | Question 44 | 0,37 | 0,39 |
| | | Question 16 | 0,55 | 0,35 | Multiplication in Natural Numbers | K12 | Question 46 | 0,63 | 0,47 |
| | K5 | Question 20 | 0,53 | 0,65 | | K13 | Question 50 | 0,63 | 0,67 |
| | K6 | Question 24 | 0,77 | 0,30 | Division in Natural Numbers | K14 | Question 54 | 0,56 | 0,41 |
| | K7 | Question 27 | 0,44 | 0,37 | | | Question 58 | 0,60 | 0,49 |
| | | Question 28 | 0,57 | 0,47 | | K15 | Question 59 | 0,60 | 0,54 |
| Addition in Natural Numbers | K8 | Question 29 | 0,86 | 0,52 | | | Question 60 | 0,62 | 0,46 |
| | K9 | Question 33 | 0,57 | 0,36 | | K16 | Question 63 | 0,65 | 0,59 |
| | | Question 34 | 0,51 | 0,33 | | K17 | Question 66 | 0,43 | 0,51 |
| | | Question 35 | 0,60 | 0,54 | | | Question 67 | 0,47 | 0,62 |
| | | Question 36 | 0,61 | 0,44 | | | Question 68 | 0,62 | 0,72 |

| | | | |
|---|---|---|---|
| Number of People | 136 | Standard Deviation of the Test | 12.28 |
| Test Average | 56,7 | Average Difficulty of the Test | .56 |
| KR-20 Value | .885 | Average Discrimination of the Test | .45 |

**Table 5:** The Distribution of the Items in the Final Achievement Test for the concept of place value According to Difficulty Categories and Levels of Discrimination

| Item Difficulty | | | Item Discrimination | | |
|---|---|---|---|---|---|
| | **Number of Items** | **%** | | **Number of Items** | **%** |
| Very easy | 3 | 11 | Very good | 19 | 68 |
| Easy | 3 | 11 | Good | 7 | 25 |
| Medium | 22 | 78 | Improvable | 1 | 3,5 |
| Hard | 0 | 0 | Should be removed | 1 | 3,5 |
| Very hard | 0 | 0 | | | |
| **Total** | **28** | **100** | **Total** | **28** | **100** |

When the data in Table 5 is examined, it is seen that 78% of the items are of medium difficulty and 22% are easy and very easy. There are no difficult or very difficult items in the achievement test. Again, 68% of the items had a very good discriminative power and 28% had a good discriminative power. Based on these findings, it can be said that the item difficulty of the achievement test was of medium level and the test consisted of items with very good discrimination power. According to Turgut and Baykul (2012), the discriminative power of the item is related to whether the item measures the desired

behavior or not, because it discriminates between those who have a particular behavior or not, so the item discrimination index can also be called as item validity. Therefore, it can be said that the internal consistency of a test with good item discrimination index is good (Anastasi, 1988).

## 4. Discussion and Conclusion

When the achievement tests in the field of mathematics were examined, an achievement test developed for the concept of place value could not be found. There; in this study, it is aimed to develop an achievement test with proven validity and reliability for the concept of place value in natural numbers for 4th grades.. While developing the achievement test, the steps to be followed while developing the concept of place value, which were determined by Turgut and Baykul (2012), were taken into consideration. Firstly, the table of specifications was prepared to ensure the content validity; critical acquisitions were determined and presented to the expert opinion. A draft achievement test consisting of 68 questions was developed for 17 acquisitions determined by taking expert opinion. The draft achievement test was applied to 136 4th grade students as a pilot study. Item difficulty and discriminative indices and KR-20 value and reliability values were calculated for the achievement test implemented. As a result of item analysis, very easy-easy and very difficult-difficult items were removed from the test without reducing the content validity. In addition, items with a low discrimination power were excluded from the draft achievement test without reducing the content validity. The average difficulty of the final achievement test consisting of 28 questions was .71; the average discrimination power was .45 and the KR-20 value was .885. These findings show that the item difficulty of the developed achievement test was of medium level, the test is quite reliable and consisted of items with very good discrimination power. As a result, an achievement test was developed which could contribute to the field for the concept of place value in natural numbers at the primary school 4th grade level.

**Acknowledgement**
The actual research is part of the doctoral dissertation entitled '*Learning trajectory-focused analysis of the evaluation of the success of learners by class teachers in mathematics teaching'* presented at Gazi University Institute of Educational Sciences, in November 2019.

## References

Anastasi, A. (1988). *Psychological testing*. New York: Macmillan Publishing.

Arslan, S. & Ubuz, B. (2009). *Sayılarda basamak değeri kavramı ve öğrencilerin yaşadığı zorluklar.* Ankara: Pegem Akademi

Başer, N. (1996). *Ders geçme ve kredi sisteminde lise öğrencileri için bir matematik başarı testi tasarımı ve uygulanabilirliğinin araştırılması*. Doktora tezi, Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü, İzmir.

Büyüköztürk, Ş. (2007). *Sosyal bilimler için veri analizi el kitabı*. Ankara: Pegem A Yayıncılık.

Büyüköztürk, Ş., Çokluk, Ö. & Köklü, N. (2011). *Sosyal bilimler için istatistik*. Ankara: Pegem Akademi.

Fidan, E. (2013). *İlkokul öğrencileri için matematik dersi sayılar öğrenme alanında başarı testi geliştirilmesi.* Yüksek Lisans Tezi, Ankara Üniversitesi Sosyal Bilimler Enstitüsü, Ankara

Gönen, S., Kocakaya, S. & Kocakaya, F. (2011). Dinamik konusunda geçerliliği ve güvenilirliği sağlanmış bir başarı testi geliştirme çalışması. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi*, 8(1). 40-57.

Karip, E. (2012). *Ölçme ve değerlendirme*. Ankara: Pegem Akademi

Kaya, N. (2015). Başarı testleri ve eğitim. Erişim Tarihi 12 Şubat 2019. *https://www.egitimbilim1.netsentez.com/2015/09/basar-testleri-ve-egitim.html*

MEB. (2018). *İlkokul matematik dersi 1-4. sınıflar öğretim programı*. Ankara: MEB.

Narlı, S. & Başer, N. (2008). Küme, bağıntı, fonksiyon" konularında bir başarı testi geliştirme ve bu başarı testi ile üniversite matematik bölümü 1. sınıf öğrencilerinin bu konulardaki hazır bulunuşluklarını betimleme üzerine nicel bir araştırma. *Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi Dergisi*, 24, 147-158.

Özçelik, D. A. (2010). *Test hazırlama kılavuzu*. Ankara: Pegem Akademi.

Şahin, Z. & Keşan, C. (2017). Bir başarı testi geliştirme çalışması: Beşinci sınıf öğrencilerinin geometri kazanımlarını ölçmeye yönelik bir başarı testi geçerlik ve güvenirliğin araştırılması. *IJTASE*, 6 (3), 47-57

Temizkan, M. & Sallabaş, M. E. (2011). Okuduğunu anlama becerisinin değerlendirilmesinde çoktan seçmeli testlerle açık uçlu yazılı yoklamaların karşılaştırılması. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*. Sayı 30.

Thompson, I. & Bramald, R. (2002). An investigation of the relationship between young children's understanding of the concept of place value and their competence at mental addition. *Department of Education University of Newcastle St Thomas Street Newcastle upon Tyne NE1 7RU*.

Turgut, M. F. & Baykul, Y. (2012). *Eğitimde ölçme ve değerlendirme*. Ankara: Pegem Akademi.

Üçgül Öcal, İ. (2011). *İlköğretim 6. sınıf matematik dersi sayılar öğrenme alanı için bilişsel hazır bulunuşluk testinin geliştirilmesi.* Yüksek lisans tezi, Ankara Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.